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Customized Wardrobe: Clothing according to user

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Abstract

Ecological and ethical innovations, as well as new methodologies that meet the real needs of consumers or users are very important for fashion become more sustainable. However, the individual is, in the most cases, the main element for that. Generally the consumer throws away his garment not because it has “low quality” or “it is out of fashion” but rather having a failed relationship between him and the product. This proposal work is an idea which plans to reduce the fashion product obsolescence, valuing and maximizing each individual's wardrobe and showing how human factors can be helpful in all process. It will make stronger the effective relationship between consumers and garment because they will be able to construct and deconstruct their clothing, according to their personal taste as well as to their physical type or their genetically determined entity, their somatotype. Inserting modular upgrades in different pieces of clothing it will allow a constant wardrobe renewal, providing the exchange of deteriorated components, colors, materials, shapes and silhouettes. Many parts can disassemble or not, like a puzzle, and they will depend on the occasion in which they are going to be used, or even from the physical type of who will wear them. Therefore, for their achievement, it will be need performing practical tests in a piece of garment to verify the way of sewing it and to study its usability in different physical types.

Keywords: Consumer; Costumizing clothes; Somatotypes in fashion; Physical types; Sustainable fashion design

1. Introduction

Fast fashion clothing has been characterized as a chronic and ineffectual model system causing "over-consumption" and getting a rubbish generator. Social, environmental and economic impacts are taking place in the

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supply chain because many items of clothing are created will not be purchased or if there will happen they will also easily be discarded.

The systematic and successive changes in Fashion process that are adopted at different times and different speeds, let designers be on the front side to accept all changes. At the same time they must create products, in the opposite direction, with ethically conscious pathways and stimulate the good sense for future consumers and users.

According to some surveys which were made in 2011, the active female people had the habit of buying at least 1 or 2 pieces of clothing from the latest trend. Their most important requirements to buy clothing were "personal taste" and "necessity, being visible a growing concern about the rationalization of garments they didn't need effectively 1. These results fit to the target segmentation theory that has been analyzed with personality variables and lifestyles preferences, instead of demographics values 2. However, fashion retail still offers a great amount of unwanted products instead of improving their services, especially in personalized products sales, as customized ones.

Introduce Human factors, either in human or interaction area, to improve empathy between product and a potential consumer is a sustainable way to minimize some impacts are realised in the life cycle of fashion products.

There are points in the lifecycle where interventions can be made to become the wearer' wardrobe more sustainable. "Designer" will make decisions to have better consequences either in life cycle or in user and the "consumer" will have best planned end-of-life options, instead of disposal items easily (Fig.1a and1b).

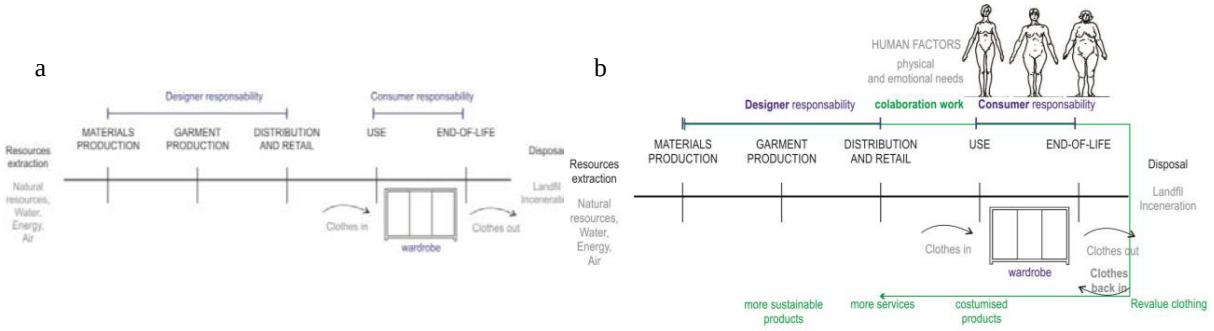


Fig. 1. (a) The Life Cycle of Fashion and principal points where interventions can be made: "Designer" and "Consumer/User"; (b) The Wardrobe changes with better sustainable solutions between designer and consumer/wearer collaboration.

On the other hand, clothing is usually made for stereotype bodies and neither fit well for each individual physical type nor get better his appearance. So, a collaboration work will become both designer and wearer more engaged with needs of each other. Designer creates less tiring products and the user/wearer will be able to participate in the construction of his customized clothing.

2. Objectives

Remake and rethink the way to project, produce and consume clothing has been research and analyzed among academics and professionals. The more personalized goods designer will be creating, more long-lasting items will have used. So, this proposal is a rethought work will show how essential features of human body can be useful in creating a more sustainable wardrobe.

Optimizing the wardrobe lifetime does not guarantee a reduction of resources but it can promote other type of user behavior, let him think about the clothing use and its functionality or even as the necessity to acquire it. The consumer knows that not all types of garments are used in the same way because some of them have longer lifespan than others but instead of discarding some items he probably may keep in and reuse them later.

Moreover, this proposal will prove that is possible to create a sustainable and transformable wardrobe in accordance with consumer's physical type, changing his image and hiding esthetic aspects less beautiful too.

3. State of the art

3.1. Customizing garments

Many requirements must be considered so that the garment can be dynamic, transformable and adaptable in different occasions and with different users.

The customizing process involves the mass production of individually personalized goods and services. The choice of the products is often selected by the client during a range of design proposals were presented in a digital platform [3].

This E-System Design is more advantageous to producer than the consumer and doesn´t seem to work well in Fashion products because the individual, special the one with greater involvement in fashion, neither touch the products and feel textures nor put them on before the purchase.

Therefore, offering customized products in own real sales points would be an option to solve the gap of consumer dissatisfaction from the purchase online or from other local e-commerce system. The process of that customized clothing production would be different from the conventional one, once the garment need to be dressed up and changed at that moment, according to the taste (and physical appearance) of the costumer. The strategies to make it possible can be multifunctional techniques as modular concept and *do-it-yourself*, contributing for components changing.

3.2. Human factors

According some researchers, human factors are characterized into three areas, “Human/ Individual”, “Interaction/ Interface” and “Management/ Organization [4]. This proposal focuses firstly on the first area, especially in human anatomy; once the wardrobe will be created for body types of different users. The Interaction and the Management areas will only have been showed in future evaluation when wearers have dressed up their clothes and interact with them in the retail shop.

Therefore, since William H. Sheldon [5], introduced the concept of somatotypes, nutritionists, exercise physiologists and even doctors started to use that for helping themselves in projects planning. Heath-Carter[6] developed evaluation methods to quantify the localized fat along the body of each individual to identify him better. But both researchers classify people in three physical types: Ectomorphic, Mesomorphic and Endomorphic (Fig.2).

Ectomorphic people are tall and thin, with little body fat and little muscle too. They generally have difficulty in gaining weight and muscle.

Mesomorphic people are more athletic, have a good bone formation and an upright posture; they gain and lose weight without much effort.

Endomorphic people have rounded shapes and a lot of body fat; they also have muscles but they may increase weight easily.

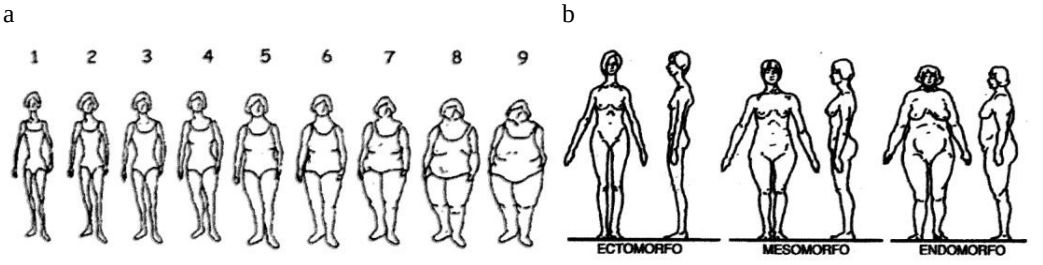


Fig. 2. (a) Body silhouettes (Adapted from Stunkard et al., 1983); (b) Three basic types of human body. Adapted from Sheldon, [5].

Many of us have features of two or even three somatotypes. The most widely known are Ecto-endomorph combination and Endo-Ectomorph combination. The ecto-endomorph combination is characterized in "Pear shape", with a slender upper body and a large fat storage in the hips and thighs. And the Endo-Ectomorph is characterized in "Apple shape", with a fat upper body and slender shape at the bottom.

Recent studies found that even in active people, there is a prevalence of the endomorph physical among in females, especially since the age of 29 [7] which means the physical body can change over the women's life-course.

In addition to that there are other studies connected to Anthropometry and Fashion Consulting that presents other peculiarities regarding human figure. The designer and writer Pezzolo [8] adds more feminine body disproportions (Fig. 3) characterizing them as: fat; bulky hips and slender trunk; big chest; short breast; short trunk long trunk; droopy shoulders; prominent belly; lack of buttocks; short legs; thin legs; big legs; low; high.

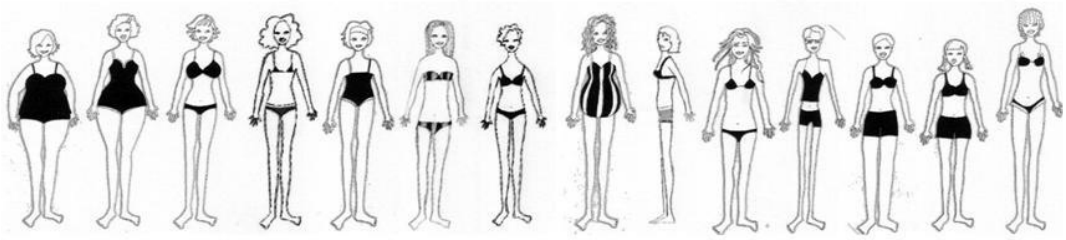
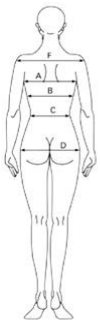


Fig. 3. Set of illustrations produced by Anita Ljung for females bodies' characteristics, according to Dinah Pezzolo [8].

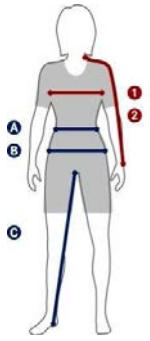
Otherwise to the physical bodies' type theory we also consider the measures of the human body, once they are proportional among different parts. Vitruvius (~ 70-25 BC) [9] have already had stated that the body's harmony was guaranteed by its inclusion into a perfect circle or square and currently many studied systems of measures have other similarities. Watching the standard measures table of the female figure and its proportions lead us to identify that (Fig.4).

a



WOMEN'S SIZE											
EU			36	38	40	42	44	46	48	50	52
USA			2	4	6	8	10	12	14	16	18
DE			32	34	36	38	40	42	44	46	48
			XS		S		M		L		XL
Chest/Breast	A	inch	31,5	33,1	34,6	36,2	37,8	39,4	40,9	42,5	44,1
	B	cm	80	84	88	92	96	100	104	108	112
Waist	C	inch	23,6	25,2	26,8	28,3	29,9	31,5	33,1	34,6	36,2
		cm	60	64	68	72	76	80	84	88	92
Hip	D	inch	33,9	35,4	37	38,6	40,2	41,7	43,3	44,9	46,5
		cm	86	90	94	98	102	106	110	114	118
Shoulders	F	inch	13,4	14	15	15,5	16,1	16,5	16,8	17,1	17,4
		cm	34	35,6	38	39,4	41	41,8	42,6	43,4	44,2
Sleeve Lenght CB	G	inch	29,2	29,8	30,6	31,1	31,7	32,1	32,4	32,6	33
		cm	74,2	75,7	77,6	79	80,5	81,6	82,3	82,7	83,7

b



Find your size – Body measurements in cm

	34 (XS)	36 (S)	38 (M)
1 CHEST	77-80	81-84	85-88
2 ARM LENGTH	71	72	73
A WAIST	61-64	65-68	69-72
B HIP	86-89	90-93	94-97
C INSEAM	80	80	80

Fig. 4. (a) European measures of standard female body (retrieved in http://www.ableammo.com/catalog/Beretta_Clothing_Chart.php); (b) Body measures in cm. (retrieved in http://www.primera-sports.com/sizing-guides/sizing.aspx)

The standardized ergonomics measures for female body ranges from 32 to 52 in European numbers as exposed in figure 4 and checking the table we can see the similarity between some dimensions such as the breast measure and hip measure or the arm length and inseam measure.

3.3. An essential wardrobe

Some writers with experience in fashion consulting and teaching as Tim Gunn [10], Rita Wilson [11] or Mary Lou Andre [12] value special items of clothing. They are fundamental pieces (the "basics" that general people like wearing) and here are characterized by the "black dress", the "polo shirt", the "t-shirt", the "twin-set", the "blazer",

the "jeans", the "trench-coat", "black pants", a "white shirt", the "skirt", the "day dress", the "training suit", and others like a "sweater", a "top", the "cardigan", the "jacket", a "shorts", a "leggings", a "cape", a "pullover", etc (Fig.5a).

According to Baldini [13] some of these clothes can be used in everyday life or in sleepwear or party clothes. Its ability to take on different meanings with minimal changes depends on the design tool during its conception. Thus, designer can rebuild the basic concept of pattern making with many elements of creation such as the "silhouette" (Fig.5b), "proportion and line", "function", "details", "color", "materials", "finishes", etc [14].

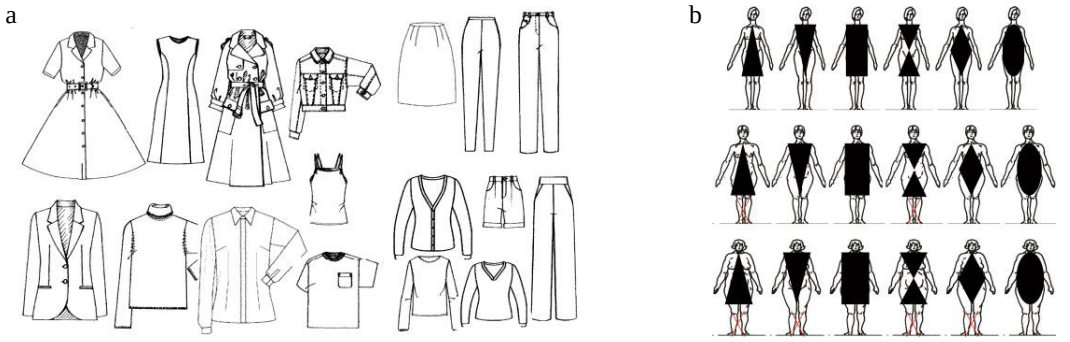


Fig. 5. (a) The garments which would be important in a wardrobe; (b) Silhouettes can change visual perceptions of bodies.

4. Proposal: customized wardrobe

Considering the review we may ask: If there are several experts who have based on the human body's morphology to improve the performance of each individual why not working from his own wardrobe to improve its appearance too?

Thinking about a sustainable way to design fashion and to create a multifunctional wardrobe according to the body's user let us rethink about the way and why people use their clothes. In addition to thinking about the human body we have to go back for its buying criteria data. According to users, the majority of individuals do not considered innovative when they choose clothing. They prefer using formal clothing for professional life and varying in accessories arrangements[15] or even wearing basic clothing during the week [16].

Thus, instead of planning a great amount of clothing that would be quickly used and discarded, we propose an idea to maximize the actual basic wardrobe at the same time people would satisfy their needs. To make that it must be planned pieces of garment able to be transformed in multifunctional pieces.

Therefore the metabolism of the future wardrobe will change by the sustainable wearer that will have more personalized products and will not disposal items easily, keeping transformable garments for much longer than conventional ones.

4.1. Garment customization methodologies

Multi-functionality or *Do-it-yourself* are both methodologies available to be included in the real garment customization. The first because it works on transformable garment allowing parts exchange and the other one because it promotes a good relationship between product and costumer.

The multifunctional garment arose to fill some wanted requirements in the new lifestyles and "many designers of super modern clothing have adopted a modular system of dressing in an attempt to simplify the complexities and unify the discontinuities of modern urban life"[17]. Quinn attests that the traditional wardrobe does not follow the changing of social and cultural needs, defending a clothing design based on changeable characteristics[18]. He even differentiates three types of transformable clothing: 1) the clothing which is only changed by its surface (appearance or texture); 2) The garments that takes two or more design possibilities (reversible pieces); and 3) garment that can be converted in multiple designs including objects (a suitcase and a hat at the same time for example).

In DIY (Do-it-yourself) design process plays a social role where the costumer becomes a designer too. DIY has evolved since the products and services increased substantially, solving economically many families lives. In fashion it becomes known with *Burda* magazine being useful for household ladies that started themselves to be the family dressmakers [19].

Ellen Lupton [20] wrote that DIY has developed due to three major factors: 1) The increase of people who have achieved high levels of awareness in Design; 2) the access to publishing tools *Do-it-yourself*; and 3) the desire to majority of consumers want to be less dependent of brands and preferring create their own purposes.

The concept of "Design for user participation" has also to be a point of interest for traders and retailers, as a way to get customer loyalty[21]. According to Caldwell and Workman's research [22] fabric retailers had believed their consumers had been interested in news technologies for custom patterns making, as the computer-aided design (CAD), "body scanning" and intelligent systems. Some examples are "MeJeans" which offers customization of Jeans, the "Nike-ID" for the production of tennis, or even "taggerbags" to build our own bags but all of them works on digital platform.

5. Methodology

In the new Design projects the subject of study has no longer just the aim product aesthetics but the function and customer satisfaction [23]. In fashion design process there are some elements really important as the silhouette or the proportion of a garment, which their combination can create infinite and diverse possibilities. However not all of them are appropriated to all kind of bodies.

In addition to that, people buy items to have a good appearance and look elegantly [24] so we start to analyze the three somatotypes (ectomorph, endomorph and mesomorph bodies) to verify the silhouette which fit better for each one (Fig.6a). After that we will consider the proportion and line of basic garments to validate their transformable potential in practical working.

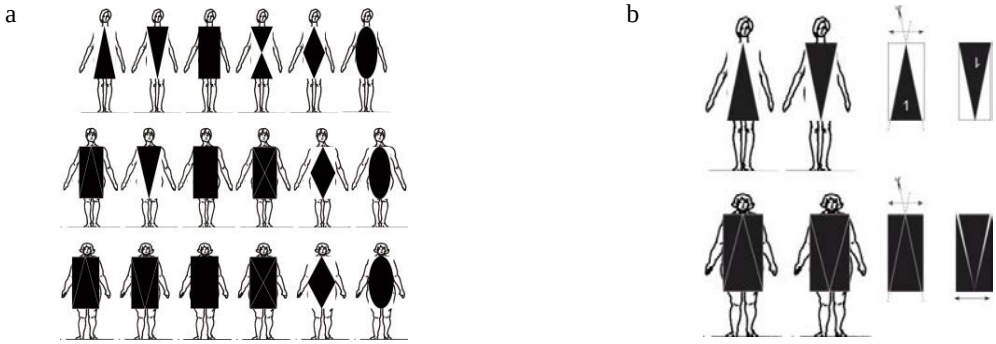


Fig. 6. (a) A Square silhouette can change visual perceptions of bodies through modular systems; (b) Examples of Cutting silhouettes.

Connecting the concepts of clothing building to the user's physical shape it is possible to help the wearer to get better his own visual perception at the same time each garment is able to become longer or wider or even be different in other piece, combining with other elements from other pieces (Fig.6b).

5.1. Practical working

Transformable garment is usually made by traditional pattern making but it can also be produced through three-dimensional pattern making *(drapping)*. In the traditional concept which clothing change removable material, the separation of pieces or layers are essentially done by zippers, ribbons or buttons but there are clothes that doesn't need to take off pieces. They can be produced in extensible material to cover different bodies and take more than one design possibility having several meanings in the same product (as a skirt and dress at the same time). In both

processes there is a wide range of possibilities to dress up and the wearer can choose a combination that he/she want or need.

Having the fundamental concern to rationalize clothing in wardrobe (through the variety of connections and disconnections of parts), the applied methodology will be based on sketches and prototypes from blocks of basic garments (fig.7a) in order to create well-made multifunctional clothes (fig.7b).

The practical working requires experimentation in each block (in this case the European number of 36) to know how cutting lines of each item is going individually to join with another one.

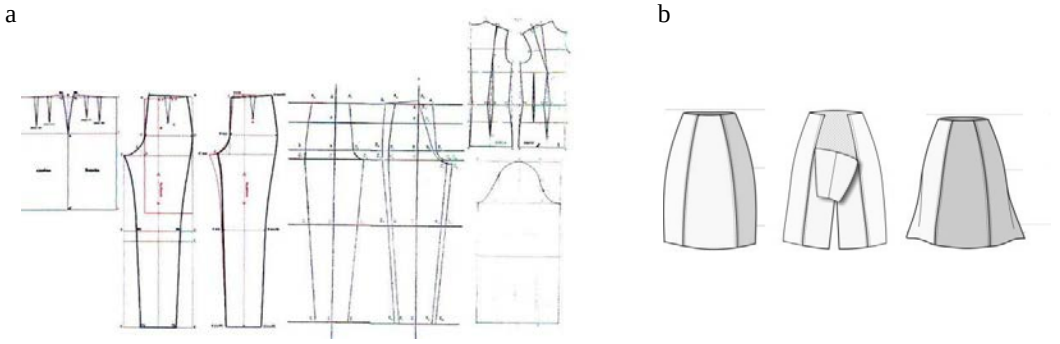


Fig. 7. (a) Samples of skirt block, pants block, bodice block and sleeve block; (b) A skirt and short sample results from practical working. By removable vertical panels it is possible to change texture, color, function and silhouette.

Considering the affinity of measures were exposed before (in Fig. 4) as length knee and inseam measure or arm length and inseam measure it is possible to build different functions in one piece (Fig.8a) or build different pieces of garment with a same component (Fig.8b)[25].

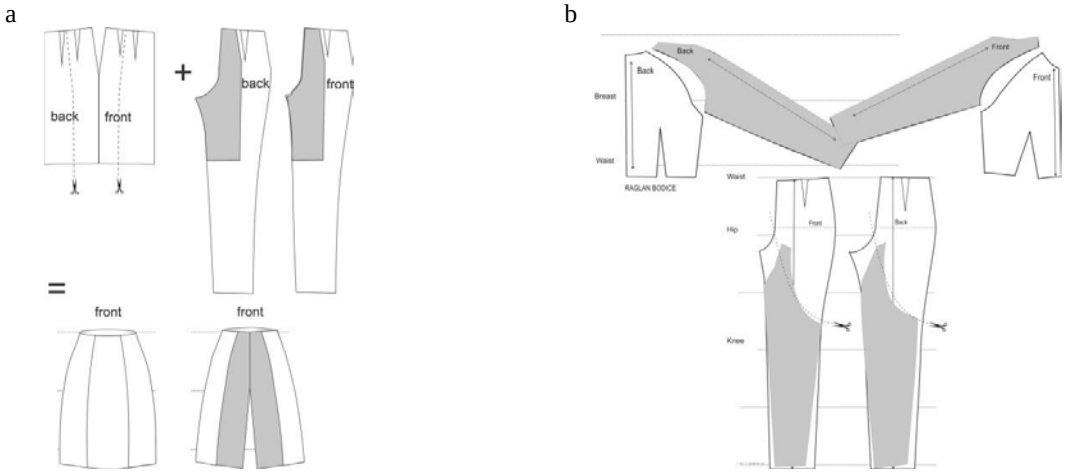


Figure 8: (a) Practical working playing with length knee and inseam measure; (b) Practical working playing with arm length and inseam measure.

These samples are the first garments will be transformed. Different types of finishes are testifying to allow wearer change colors, patterns, shapes, lengths and heights.

6. Conclusions

Being interesting the measures affinity between the human body and the construction of transformable clothing since there is no scientific research in this area, we do not consider this work finished. Designing for changing shapes let designer acquire knowledge of radically clothing construction at the same time he has to recognize the creative abilities and limits (physical and psychological) of the end wearer.

According to the review, the possibility of constructing different silhouettes or textures wherein each garment is able to become longer or wider or even be different in other piece classifies this type of clothing as a timeless design and much more sustainable than conventional clothing. It answers to the tiredness of basic product also featuring great versatility of styles and ways to wear. In addition to that it shows the importance of repair services in stores to let consumers replace only worn components instead of buying a whole piece of garment.

Although the purpose of this work is to create a complete wardrobe, which components will accommodate the waist, height, line of the wearer we only testified a sample (the basic skirt that change for shorts through removable vertical panels by zippers). We realize that may cause interest in future wearer by the ability to be changed according to his taste and to his physical body but technically is a hard approach which doesn't work for all types of fabrics or embellishments. One of the greatest difficulties of this kind of clothing is not how it transforms but rather how the qualitative details are made for a good performance.

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References

[1, 16, 24] Morais, C., C. Carvalho, and C. Broega, A design tool to identify and measure the profile of sustainable conscious fashion costumer in Autex2011 - 11th World Textile Conference at ENSISA. 2011: Mulhouse, France. p. 388-393.
[2] Solomon, M., Os segredos da mente dos consumidores. 1ª ed. 2009, V. N. Famalicão: Centro Atlântico, Lda. 229.
[3] Ulrich, P.V., L.J. Anderson-Connell, and W. Wu, Consumer co-design of apparel for mass customization. Journal of Fashion Marketing and Management, 2003. 7(4).
[4] Montagna, G. and C. Morais, Fashion design and garment performance: Human factors in fashion design projects, in 5th International Conference on Applied Human Factors and Ergonomics. 2014: Krakow, Poland.
[5] Sheldon, W.H., S.S. Stevens, and W.B. Tucker, The Varieties of Human Physique. 1940, New York: Harper and Brothers.
[6] Heath-Carter, C. J.E.L., and B.H. Heath, Somatotyping - Development and Applications. 1990: Cambridge University Press.
[7] Almeida, A., et al., Somatotype analysis of physically active individuals, in J Sports Med Phys Fitness. . 2013. p. 268-73.
[8] Pezzolo, D.B., Moda Fácil 2007, Cascais: Quinto Selo Edições.
[9] Bahr, B. (2009) Beyond Drawing Basics: Proving Leonardo's Theories on Human Proportions. artistdaily
[10] Gunn, T. and A. Calhoun, Tim Gunn's Fashion Bible: The fascinating history of everthing in your closet. 2012, New York: Gallery Books, Simon & Schuster, Inc.
[11] Wilson, R., Age-Proof Wardrobe Basics, in The Oprah Winfrey Show O. Winfrey, Editor. 2010 [12] Mary Lou Andre (2004)
[13] Baldini, M., A Invenção da Moda - As Teorias, os Estilistas, a História. 2006, Lisboa: Ediçoes 70 Ltd. 143 [14] (Seivewright, 2007)
[15] Cantista, I., et al., Values and Fashion Consumption of Working Women in Europe, in 7Th International Congress Marketing Trends 2008: Venice. p. 27.
[17] Bolton, A., The Supermodern Wardobre. 2002, London: V&A Publications. [18] (Quinn, 2008, p. 117)
[19] Nunes, R. and C. Carvalho, Uma nova estratégia de design de produto virada para o "Faça você mesmo - Fundamentos, aplicabilidade e consequências num futuro social sustentável", in Faculdade de Arquitectura. 2010, Universidade Técnica Lisboa.
[20] Lupton, E., Do it yourself. 2006, New York: Princeton Architectural Press.
[21] Pine, B.J., Mass Customization: the New Frontier in Business Competition. 1993, Boston, MA: Harvard Business School Press.
[22] Caldwell, L.F. and J.E. Workman, Retailers' perceptions of the effects of garment complexity on interest in customized patterns". Clothing and Textiles Research Journal, 1991. 9(3): p. 1-6.
[23] Vezzoli, C. and E. Manzini, Design for Environmental Sustainability. 2008: Springer-Verlag London Limited.
[25] Morais, C., A Sustentabilidade no Design de Vestuário, in Faculdade de Arquitectura. 2013, Universidade de Lisboa: Lisboa. p. 216